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RESEARCH ARTICLE

Functional Movement Analysis in 11-13 Age Group Football Players: Total Score, Asymmetries, and Technical Skill Tests

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Abstract
This study was conducted with the aim of determining the relationship between Functional Movement Scores (FMS) and technical skills in 11-13-year-old football players undergoing basic training in football schools and various youth academies, as well as identifying any asymmetries. A total of 180 football players aged between 11 and 13 participated in the research. The participants were subjected to measurements including height, weight, Body Mass Index (BMI), FMS, Yeagley Soccer Test, and Short Dribbling Test. The data obtained were analyzed using a statistical software package. Descriptive statistics were calculated for the football players. Spearman Rank Differences correlation analysis was performed to determine the relationship between functional movement analysis results and technical skills according to age groups. The Wilcoxon Signed-Rank test was conducted to identify asymmetries in football players. The significance level was set at 0.05. The results of the study indicate that athletes with higher FMS scores also performed better in football skills tests. Furthermore, it was found that there were asymmetries in the movement patterns of 11 and 13-year-old football players, except for Rotatory Stability scores, with left asymmetry scores being lower than right asymmetry scores.

Keywords
FMS, Exercise, Technical skills, Short Dribbling Test, Yeagley Soccer Test

INTRODUCTION

Football is a popular branch that has been played for many years and has been dragging the masses after it. It is a game in which two teams of eleven players compete and aim to score goals in the opposing goalpost. Like every game, it has its own rules and players must fulfill certain skills. Since soccer can be played easily in many areas and conditions, it is preferred at a young age. Athletes need to be physically and cognitively well-developed in order to successfully fulfill these skills (Ali, 2011; Babkes & Weiss, 1999).

Football is a sport that requires a high level of agility, speed, endurance, and physical effort, and it is played at a basic level with small age groups. To be successful, players need to repeatedly demonstrate high intensity performances, including running at high speeds, sprinting, changing direction, passing, ball control, and scoring goals, all of which are specific football skills. Recognizing the skill element required to play football is crucial. Indeed, it has been determined that the most important activities affecting the outcome of a match include one-on-one battles in offense and defense, accurate passing, corner kicks, and free kicks (Datson et al., 2017).

According to official FIFA data, 265 million players and 5 million referees and officials are active in the game of football worldwide. Identifying and nurturing talented players at an early age leads to sporting and financial success.

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For this reason, national federations and many football clubs devote significant resources to the identification and development of young and talented players (Fuller et al., 2012).

Football is a game where physical performance, technical skills, and cognitive processes are the most intense. The game structure of soccer has become a more dynamic and faster game in terms of technical aspects in recent years. For this reason, there is a need for talented soccer players who have technical characteristics such as speed, strength, endurance, etc., as well as good cognitive processes and the ability to make fast and accurate decisions.

Bringing technical skills to football players at a young age in parallel with cognitive processes is a successful strategic step in raising a talented population. While transferring cognitive decision-making mechanisms to football players who are at the age of development in physical and physiological aspects, gaining technical skills will enable them to be more successful (Paśko et al., 2021). For this reason, a high level of education is needed in order to play and train football correctly. On the other hand, these processes are supported by studies carried out under talent screening (Bojkowski et al., 2022).

Researchers have stated that since soccer is a multifactorial sport, talent identification methods should focus more on selecting skills that match technical skills in a game, such as passing and dribbling, and the validity of test batteries should be evaluated longitudinally (Rowat et al., 2016). Many test protocols are used to identify talented athletes. FMS is among these test protocols. FMS, which includes the selection and analysis of movements suitable for the sports branch, provides information about the individual movement patterns of the athlete. It is also used to determine the effect of these selected movement patterns on performance. FMS assesses functional movement deficiencies based on proprioception, mobility, and stability and is utilized to predict weaknesses in the body by identifying asymmetry and weak links in fundamental functional movement patterns. The presence of movement asymmetry and functional disorders can increase an athlete's risk of injury and lead to the development of movement patterns that emphasize and correct faulty movements.

In today's world, having knowledge of athletes' physical characteristics and technical skills has become a necessity to achieve success on the international stage. Possessing this information about athletes facilitates the selection of young talents for coaches and clubs. On the other hand, knowing the physical attributes makes it easier to create individualized training programs. Additionally, screening fundamental movement patterns in athletes plays a crucial role in determining whether they have a solid foundation before moving on to more challenging activities. Therefore, the relationship between functional movement analysis and technical skills among soccer players of a certain age group was investigated.

MATERIALS AND METHODS

Research Design

The research was designed as an experimental study. The Exploratory Model, one of the Relational Screening Models, was used as the research model due to the examination of the relationship between two or more variables. The study was approved by Çanakkale 18 Mart University Clinical Research Ethics Committee (Approval Number: 2019/20). The study was conducted in accordance with the Declaration of Helsinki.

Research Group

The population of the study consisted of soccer players and the sample consisted of soccer players residing in Çanakkale. A total of 180 soccer players playing soccer in Çanakkale province and participants between the ages of 11 and 13 were included in the study.

Data Collection Tools

Height, weight, Body Mass Index (BMI), FMS test, Yeagley Soccer Test, and Short Dribbling Test were performed on the soccer players participating in the study.

Weight Measurement: SECA (Germany) brand electronic scale was used for body weight measurement of soccer players.

BMI calculation: Body Mass Index (BMI) = Body Weight / Height^2 (Anonymous, 1980).

Functional Movement Analysis (FMS): The FMS test was performed on the parquet floor of the gymnasium. After a standard warm-up protocol, a test protocol consisting of seven movements was applied. Each movement was evaluated between 0-3 points and the FMS score was calculated by summing the scores obtained from the movements between 0-21 points. Right-left asymmetries were also calculated (Cook et al., 2006).

Yeagley Football Test: The test protocol used to measure the technical skills of soccer players was applied on synthetic turf. Footballers started bouncing the ball with the start command. After 30 seconds of bouncing the ball in the designated area (4x4m), soccer players were given 2 attempts, and the maximum number of bounces was recorded (Yeagley, 1972).

Short Dribbling Test: The test protocol used to measure the specific changing direction and dribbling skills of soccer players was applied on synthetic turf. Footballers dribbled the ball in the fastest way between the funnels and the test was terminated in the square area at the end of the track. Photocells were placed at the start and end of the track. After 2 trials, the best score was recorded (Bangsbo & Mohr, 2013).

Data Analysis

A statistical package program was used for statistical analysis, calculations, and graphics. Descriptive statistics values of the variables of the athletes participating in the study were calculated. Whether the measurement values of the athletes showed normal distribution characteristics was analyzed according to the Kolmogorov-Smirnov statistics. The Spearman Rank Difference Correlation Analysis, which is a nonparametric test, was performed for the correlation between FMS scores and technical skill tests. In order to determine the FMS asymmetries in soccer players, the Wilcoxon Signed Ranks Test, one of the non-parametric tests, was performed since multiple (right-left) observations were made on the same group of soccer players (Atan & Ünver, 2019; Bayraktar, 2008; Hamarat, 2017). The significance level was accepted as $p<0.05$ and $p<0.01$.

RESULTS

Table 1. Descriptive Statistics on Physical Characteristics and Technical Skill Tests of the Athletes Participating in the Study

	Group	N	Min	Max	Mean	SD
Height (cm)	11	90	134	162	143.99	8.00
	13	90	150	162	155.86	3.90
Body Weight (kg)	11	90	30	54	37.54	8.94
	13	90	33	61	50.19	8.04
Body Mass Index	11	90	14.10	28.70	17.97	3.31
(kg/m^2)	13	90	14.40	24.20	20.61	2.63
Short Dribbling Test	11	90	12.80	16.64	14.39	0.98
(sec)	13	90	12.05	15.99	13.82	1.26
Yeagley Football Test	11	90	20	35	26.58	2.71
(again)	13	90	26	43	33.34	3.68

Descriptive statistics of the height, body weight, BMI and the results of the Short Dribbling Test and Yeagley Football Test, which are among the technical skill tests, of the athletes participating in the study were evaluated and the relevant data are given in Table 1.

Table 2. Descriptive Statistics of FMS Scores of the Athletes Participating in the Study

		Group	N	Min	Max	Mean	SD
Deep Squat	Total	11	90	1	3	1.88	0.47
		13	90	2	3	2.40	0.49
Hurdle Step	Right	11	90	2	3	2.12	0.32
		13	90	2	3	2.38	0.48
	Left	11	90	1	2	1.80	0.40
		13	90	1	2	1.90	0.30
	Total	11	90	1	2	1.80	0.40
		13	90	1	2	1.90	0.30
In-line Lunge	Right	11	90	2	3	2.12	0.32
		13	90	2	3	2.61	2.61
	Left	11	90	1	2	1.68	0.47
		13	90	1	2	1.89	0.31
	Total	11	90	1	2	1.68	0.47
		13	90	1	2	1.89	0.31
Shoulder Mobility	Right	11	90	1	3	2.67	0.49
		13	90	2	3	2.89	0.31
	Left	11	90	1	3	2.10	0.39
		13	90	2	3	2.13	0.34
	Total	11	90	1	3	2.10	0.39
		13	90	2	3	2.13	0.34
Active Straight Leg Raise	Right	11	90	1	3	2.27	0.46
		13	90	2	3	2.91	0.28
	Left	11	90	1	3	1.99	0.18
		13	90	1	3	2.04	0.33
	Total	11	90	1	3	1.99	0.18
		13	90	1	3	1.86	0.33
Trunk Stability	Total	11	90	1	3	1.86	0.48
		13	90	1	3	2.00	0.21
Rotatory Stability	Right	11	90	1	3	1.91	0.38
		13	90	1	2	1.82	0.38
	Left	11	90	1	3	1.61	0.55
		13	90	1	2	1.82	0.38
	Total	11	90	1	3	1.61	0.55
		13	90	1	2	1.82	0.38
Total FMS Score	Total	11	90	11	15	12.91	1.05
		13	90	12	16	14.19	0.82

FMS scores of the athletes participating in the study and descriptive statistics of the values obtained were evaluated and the relevant data are given in Table 2.

Table 3. FMS Asymmetries of 11-year-old Athletes Participating in the Study

Variables	Rows	N	Row Mean	Row Total	z	p
Hurdle Step Right-Left	Negative Queues	26	13.50	351.00		
	Positive Rows	0	.00	.00	-4.874	.000
	No Difference	60				
In-line Lunge Right-Left	Negative Queues	37	19.00	703.00		
	Positive Rows	0	.00	.00	-5.879	.000
	No Difference	53				
Shoulder Mobility Right-Left	Negative Queues	50	25.50	1.275.00		
	Positive Rows	0	.00	.00	-7.005	.000
	No Difference	40				
Active Straight Leg Raise Right-Left	Negative Queues	26	14.00	364.00		
	Positive Rows	1	14.00	14.00	-4.811	.000
	No Difference	63				
Rotatory Stability Right-Left	Negative Queues	27	14.00	378.00		
	Positive Rows	0	.00	.00	-5.196	.000
	No Difference	63				

The 11-year-old athletes' Hurdle Step scores (z=-4.874, p<0. 05), In-line Lunge scores (z=-5.879, p<0.05), Shoulder Mobility scores (z=-7.005, p<0.05), Active Straight Leg Raise scores (z=-4.811, p<0.05), Rotatory Stability scores (z=-5.196, p<0.05) were evaluated. The fact that the differences between the scores were in favor of the negative ranks shows that the athletes' asymmetry-determining left-side scores from the FMS movements were less than the right-side scores. The data obtained are given in Table 3.

Table 4. FMS Asymmetries of 13-year-old Athletes Participating in the Study

Variables	Rows	N	Row Mean	Row Total	z	p
Hurdle Step Right-Left	Negative Queues	42	21.50	903.00		
	Positive Rows	0	.00	.00	-6.874	.000
	No Difference	48				
In-line Lunge Right-Left	Negative Queues	58	29.50	1.711.00		
	Positive Rows	0	.00	.00	-7.296	.000
	No Difference	32				
Shoulder Mobility Right-Left	Negative Queues	67	34.00	2.278.00		
	Positive Rows	0	.00	.00	-8.185	.000
	No Difference	23				
Active Straight Leg Raise Right-Left	Negative Queues	74	37.50	2.775		
	Positive Rows	0	.00	.00	-8.444	.000
	No Difference	16				
Rotatory Stability Right-Left	Negative Queues	6	7.50	45.00		
	Positive Rows	8	7.50	60.00	-535	.593
	No Difference	76				

According to the results of the Wilcoxon Signed Ranks Test, which was conducted to find out whether there was a difference between the right and left FMS scores of the 13-year-old athletes and to determine their asymmetry, statistically significant differences were detected between the athletes' Hurdle Step scores (z=-6.874, p<0.05), In-line Lunge scores (z=-7.296, p<0.05), Shoulder Mobility scores (z=-8.185, p<0.05), and Active Straight Leg Raise scores (z=-8.444, p<0.05). however, there were no statistically significant differences between Rotatory Stability scores (z= -535, p<0.05). The fact that the difference scores were in favor of negative ranks showed that the left-side scores, which determined the asymmetry, were lower than the right-side scores, except for the Rotatory Stability scores from the FMS movements of the athletes. The data obtained are given in Table 4.

Table 5. Correlation Between FMS Scores and Technical Skill Tests of 11 Year Old Athletes Participating in the Study

Variables	Values	FMS Total Score	Short Dribbling Test	Yeagley Football Test
FMS Total Score (points)	R	1	-.962**	.976**
	P	.	.000	.000
	N	90	90	90
Short Dribbling Test (sec)	R	-.962**	1	-.983**
	P	.000	.	.000
	N	90	90	90
Yeagley Football Test (again)	R	.976**	-.983**	1
	P	.000	.000	.
	N	90	90	90

**p<0.001

Spearman Rank Difference Correlation Analysis was performed to determine the correlation between the FMS total scores of 11-year-old athletes and their technical skill test results. As a result of the analysis, a statistically significant and negative correlation was found between the FMS total scores of 11-year-old athletes and the Short Dribbling Test results (r=-.962; p=0.000). It has been determined that as the total FMS score increases in football players, the duration of the Short Dribbling Test decreases. Additionally, a statistically significant and positive relationship was found between FMS total scores and the Yeagley Football Test (r=-.976; p=0.000). It was observed that as the FMS total score increased, the Yeagley Football Test score also increased. In addition, a statistically significant and negative relationship was detected between the Short Dribbling Test and the Yeagley Football Test. A statistically significant and negative relationship was detected between the Short Dribbling Test and the Yeagley Football Test, which are among the technical skill tests of football players (r=-.983; r=0.000). The data obtained are given in Table 5.

Table 6. Correlation Between FMS Scores and Technical Skill Tests of 13-Year-Old Athletes Participating in the Study

Variables	Values	FMS Total Score	Short Dribbling Test	Yeagley Football Test
FMS Total Score	R	1	-.860**	.907**
(points)	P	.	.000	.000
	N	90	90	90
Short Dribbling Test	R	-.860**	1	-.954**
(sec)	P	.000	.	.000
	N	90	90	90
Yeagley Football Test	R	.907**	-.954**	1
(again)	P	.000	.000	.
	N	90	90	90

**p<0.001.

Spearman Rank Differences Correlation Analysis was performed to determine the correlation between FMS total scores and Technical skill tests of 13-year-old athletes participating in the study. As a result of the analysis, a statistically negative and significant correlation was found between the FMS total scores of 13-year-old athletes and the Short

Dribbling Test results (r=-.860; p=0.000). It was determined that as the total score of the FMS score increased, the duration of the Short Dribbling Test decreased. A statistically positive and significant correlation was found between FMS total scores and Yeagley Football Test results (r=-.907; p=0.000). In addition, it was also determined that as the total score of the FMS increased, the Yeagley Football Test repetition also increased. A statistically negative and significant relationship was found between the Short Dribbling Test, which is one of the technical skill tests for football players, and the Yeagley Football Test (r=-.954; r=0.000). The obtained data are given in Table 6.

DISCUSSION

The present study was conducted to determine the relationship and asymmetries between FMS scores and technical skills of 11-13-year-old soccer players who were raised in football schools or in the substructures of various clubs and who were subjected to technical training during the basic training period. In the literature, it has been determined that there are few studies on the relationship between technical skill and FMS. In addition, it was seen that there are studies on technical skill and athletic performance (Da Costa et al., 2023; Sun et al., 2022) or injury prediction of FMS (Łyp et al., 2022; Moore et al., 2023). There were also studies on the validity of technical skill tests in soccer (Dardouri et al., 2014).

In their study, Dardouri et al. (2014) examined soccer-specific tests and their discriminative features and the reliability of these tests. A total of 92 soccer players aged 14 years participated in the study and 3 soccer-specific tests including dribbling between slalom, sprint, and agility test were examined. As a result of the study, it was reported that all three tests were reliable, that dribbling and agility tests could distinguish ability between slalom, and that these tests could be applied in football-specific skill assessments. Kelly et al. (2020) examined the relationship between technical skills obtained from match analysis and technical tests in their study. In their study in which 40 football players aged 9-11 and 58 football players aged 12-16 participated, they stated that there was a significant relationship between technical skills such as ball possession, passing, dribbling obtained from match analysis and technical skill tests in which football players participated.

The FMS test does not determine how a person will perform under load or during competition. The purpose of the FMS is not to measure sports performance. Therefore, studies that try to see if it is related to sports performance have difficulty in achieving the goal. However, FMS scores help coaches to see the predisposition of soccer players to selected soccer skills and to predict the athlete's results from the tests, as can be seen from the results obtained in our study.

McCall et al. (2015) reported in their study that most researchers recognized FMS as an injury risk assessment tool and that 66% of researchers working in elite men's football clubs used FMS often as an injury risk screening assessment tool. Vandendriessche et al. (2012) emphasized that motor coordination is an important determinant of talent in young football players. However, they also reported that studies focusing on football-specific motor skills, FMS scores, and performance have begun to be conducted more frequently in recent years. Kokstejn et al. (2019) stated that FMS is effective in testing basic motor skills and techniques in their study. For this reason, the researchers who stated that they designed this study investigated FMS, physical fitness, and soccer-specific motor skills (fast dribbling). As a result of the study, they stated that there is a relationship between the FMS test and skill (fast dribbling) in soccer players and that FMS plays an important role in the process of acquiring motor skills in pre-adolescent soccer players.

Duncan et al. (2022) examined the importance of FMS and technical skills in soccer players. In their study in which 60 male soccer players aged 8-12 years participated, the relationships were investigated using FMS, dribbling, passing, and shooting tests for the evaluation of technical skills, 15m sprint speed, long jump, and ball throwing tests for physical fitness. As a result of their study, they reported that young football players had the perception of being competent in FMS in addition to their age. Portas et al. (2016) examined the factors affecting FMS scores in soccer players in their study. In the study in which 1163 male soccer players between the ages of 8-18 participated, they determined in which movements there were differences in FMS scores. As a result of their study, they stated that there is a relationship between age and FMS and

that FMS results may be invalid in younger athletes.

Zalai (2015) stated in his study that there were right-left asymmetries and functional deficiencies in trunk stability and deep squatting from FMS movements in elite athletes aged 14-20 years. Coaches, conditioners, athletic performance specialists, physiotherapists, and other football-related researchers have emphasized that young athletes have more functional deficits than adults, which may lead to reduced technical capacity and increased risk of injury. Hujigen (2010) investigated dribbling skills in soccer players aged 12-19 years. The researcher found a relationship between speed and dribbling and reported that there was a relationship between slalom and dribbling test. He also stated that the tests measured different characteristics. Wright et al. (2015) investigated the importance of corrective exercises in FMS scores in children. Twenty-two children aged 13 years participated in the study. Children were grouped according to the FMS total score. FMS exercises were applied to the experimental group for 4 weeks. As a result of the study, they emphasized that there were no differences between the groups, well-prepared exercises may be more ideal, and emphasized the importance of future studies.

Marques et al. (2017) emphasized in their study that soccer players at different levels may still have soccer-specific movement deficiencies, even if determined by FMS. In the study conducted for this purpose, FMS scores of 103 soccer players between the ages of 14-20 were evaluated and asymmetries were determined. As a result of the research, they stated that asymmetries and functional decreases were observed in young soccer players.

As a result of the study, asymmetries were determined in 11 and 13 age group soccer players. It was also found that soccer players with high FMS scores performed better in skill tests. Based on these results, it is thought that FMS can provide coaches with preliminary information about soccer players' predisposition to dribbling and bouncing skills in skill selection. In addition, FMS, which contains patterns suitable for the movement patterns of football players, can provide coaches, trainers, and conditioners with preliminary information about the movements that are likely to be performed in the game and how they will perform in some skills (dribbling, ball bouncing, shooting, etc.) that include these movements.

Conflict of Interest

This study is based on a master's thesis prepared by the first author under the supervision of the corresponding author and the second author. There is no conflict of interest. There is no financial support provider.

Ethics Committee

Approval was obtained from Çanakkale 18 Mart University Clinical Research Ethics Committee (Approval Nummer: 11.12.2019 dated 20-02).

Author Contributions

The version published by the authors has been read and accepted. Each stage of the study was planned equally by the authors.

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